Amirkabir University of Technology
Tehran Polytechnic

Department of Aerospace Engineering

Aerodynamics I — Winter 2019

Instructor: Dr. Mehran Tadjfar

Course Objectives: To provide understanding of aerodynamics of incompressible flow with emphasis on airfoils and finite wings for second year undergraduate students.

Textbook: Anderson J.D. Fundamentals of Aerodynamics, McGraw-Hill with supplemental class notes provided by the instructor.

Grading:
10% Homework
10-25% Projects ?
65-80% Exams: 1st Midterm 26 Esfand 97, 2nd Midterm 15 Ordibehesht 97

- Review of Fluid Mechanics; Concepts and Tools:
  - Vorticity and Irrotationality.
  - Circulation.
  - The Stream Function and Velocity Potential Function.
  - Attached and Separated Flow, Streamlines.
- Coefficients of Lift and Drag.
- Von Karman Vortex Sheet.
- Aerodynamic Forces and Moments, Center of Pressure.
- Fundamentals of Inviscid, Incompressible Flow:
  - Elementary Solutions of Laplace's Equation.
    - i. Uniform Flow, Source Flow, Vortex Flow, and Doublet Flow.
    - ii. Combination of A Uniform Flow with A Source and Sink.
    - iii. Non-lifting Flow over A Cylinder.
    - iv. Lifting Flow over A Cylinder: The Kutta-Joukowsky Theorem.
    - v. Method of images.
- Potential Flow with Complex Variables.
- Incompressible Flow over Airfoils:
  - The Kutta Condition, Source and Vortex Sheets.
  - Panel Methods: Derivation and Computer Programming
  - NACA Airfoils.
  - Airfoil Design, Data and Characteristics.
  - Classical Thin Airfoil Theory.
    - i. The Symmetric Airfoil and Aerodynamic Center.
    - ii. The Cambered Airfoil and Stall Characteristics.
    - iii. Flaps, Slats and Separation Control.
- Incompressible Flow over Finite Wings:
  - Downwash and Induced Drag.
  - Winglet Design, ideas from nature.
  - Kelvin's Circulation Theorem and the Biot-Savart Law.
  - The Vortex Filament, Helmholtz's Theorems and the Starting Vortex.
  - Prandtl's Classical Lifting-Line Theory.
    - i. Elliptical Lift Distribution.
    - ii. General Lift Distribution.
  - Geometric Wing Design, Aspect Ratio and other Parameters.